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ward movement becomes slower and the *Euglenæ* begin to swerve farther than usual toward the dorsal side. Thus the spiral path becomes wider and the anterior end swings about in a larger circle and is pointed successively in many different directions. In some part of its swinging in a circle the anterior end of course becomes directed more nearly toward the light; thereupon the amount of swinging decreases, so that the *Euglena* tends to retain a certain position so reached. In other parts of the swinging in a circle the anterior end becomes less exposed to the light; thereupon the swaying increases, so that the organism does not retain this position but swings to another. The result is that in its spiral course it successively swerves strongly toward the source of light, then slightly away from it, until by a continuation of this process the anterior end is directed toward the light. In this position it swims forward.

Figs. 91 and 92, p. 135, show variations in the severity of the reaction, the second figure representing but a very slight widening of the narrow spiral in which the organism has been swimming. Fig. 93, p. 139, represents the path of a *Euglena* executing a turn of 180° by a series of similar slight widenings of the spiral.

From such evidence it would seem that the motor reflexes of *Euglena* appear in varying degrees that shade more or less gradually into each other as the strength of stimulation varies. This admirably meets the requirements of a "tropism theory" that is expected to account for the gradual but definite and errorless turning movements executed by so many bilaterally symmetrical organisms in orienting themselves with respect to a source of light.

These considerations inclined me to the view that in bilaterally symmetrical organisms the shock reactions that have no obvious connection with orientation to a stimulus and are produced by *sudden changes in intensity* of light may occupy one end of a series at the other end of which are the very small reactions by means of which the tropic turning movement is achieved. In that case the difference in effect on orientation of these extreme cases would not indicate any fundamental difference in mechanisms governing them, but rather a

pronounced difference in the magnitude of the responses to stimuli of different intensities.

Recently, however, my attention has been called to new evidence, shortly to be published by my friend, Dr. F. W. Bancroft, that in *Euglena* the mechanisms of the shock reaction and the tropic reaction are distinct. How general this observation may prove to be is not now certain. But in any case, the shock reaction can hardly be said to occupy the position of a prototype from which trialless heliotropic turning movements have been derived by any process of selection.

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AN AID TO STUDENTS

THE Academy of Natural Sciences of Philadelphia has published, as part of the aftermath of the brilliant centenary celebration of last year, an index to its publications from the first volume of the *Journal* issued in 1817 to the conclusion of the sixty-second volume of the *Proceedings* completed in 1911, making a total of eighty-three volumes. The portly index comprises 1,433 octavo pages and is divided into two sections. The first contains the titles of all the contributions to the series, arranged alphabetically under the names of the authors, and ranges from brief paragraph reports of the communications made verbally before the meetings of the academy to the classic quarto volume by Joseph Leidy on the extinct mammalian fauna of Dakota and Nebraska, and the beautiful monographs on the burial mounds of the south by Clarence B. Moore.

The second section is composed of an alphabetical arrangement, from *aalensis* to *Zythia*, of the names of every species, genus, and family described or referred to in the several volumes. It is estimated that there are about 124,600 such entries in the list and some idea of the labor involved in its preparation and arrangement may be had from the fact that the original entries under the letter P numbered 19,500, under S 16,650 and under T 10,300.

These were, of course, condensed in the arrangement, all the page references to a given name being placed under a single entry so that the printed result is much curtailed.

During the first five years of the academy's life it maintained a sort of chrysalis existence without much communication with the outside world. Of the six men who attended the initial meeting but one, the Dutchman Gerard Troost, later elected the first president, had any scientific training. At the next meeting Thomas Say was "adopted" by the others as one of the founders and he has since been regarded as one of the seven to whom the academy owes its existence. The communications to the meetings were at first confined almost solely to selections from Rees's Encyclopedia and certain text-books of science, but original observations soon became more frequent and by 1817 a sufficient amount of such material was in possession of the society to warrant the belief that an avenue of publication would be desirable. Through the interest and zeal of William Maclure, a Scotch philanthropist, the first number of the *Journal* was placed before the meeting held May 20, 1817. The volume contained contributions from Chas. A. Lesueur, Geo. Ord, Thomas Say, Thomas Nuttall, and William Maclure. Its interest and value were much enhanced by the beautiful engravings by Lesueur. It was at the time the only avenue of communication with the scientific world possessed by the working naturalists of America.

This series staggered on with intervals of quiescence until 1842, when it was decided that the *Proceedings*, which had been begun the previous year for the purpose of giving prompter publicity to the current business of the academy, supplied all that could be secured by an octavo publication.

To provide for papers requiring more elaborate illustrations than could be supplied in the octavo form, a quarto journal was started in 1847 and has been continued to the present time, the superb fifteenth volume having been published last December as the chief memento of the celebration held in March. Inciden-

tally it may be mentioned that the prompt issue of that volume, within nine months of the event it records, has been regarded all over the world as a record-breaking achievement. The illustrations to the quarto series were from the first of a high order of artistic merit. Special mention may be made of the colored illustrations of Cassin's birds, supplied by the liberality of Thomas B. Wilson; the really beautiful lithographs by Ibbotson of Isaac Lea's Melanians and Unios; and more recently the superb chromoplates of prehistoric pottery furnished by Mr. Clarence B. Moore in illustration of his monographs.

Access to the scientific contents of the eighty-three volumes, constituting one of the most important agencies in the advancement of science, will be greatly facilitated by the issue of the index which will undoubtedly be highly valued by students.

A few pages are devoted to a record of the time of publication of the several parts and volumes. The minutes, correspondence, and accessions lists of the academy were consulted to determine as many such dates as possible, and it is to be regretted that the result is not complete, the requisite data not being at hand, after the most careful search, to make it so. As far as the record goes, however, it will establish dates of publication of many researches of the first importance and help to determine many questions of priority, a matter to which the working naturalist is apt to attach much more importance than do those who value results without caring greatly as to who attains them.

EDW. J. NOLAN

SPECIAL ARTICLES

FACTORS INFLUENCING THE SURVIVAL OF BACTERIA AT TEMPERATURES IN THE VICINITY OF THE FREEZING POINT OF WATER¹

It has been held by some bacteriologists that, while temperatures about the freezing point of water are less destructive of bacterial life than those about the boiling point, low temperatures are not only unfavorable to the growth and multiplication of bacteria, but

¹ Preliminary communication.